REMARKS

This Amendment is being filed concurrently with a Request for Continued Examination (RCE).

The Final Office Action mailed July 11, 2003, has been carefully reviewed and by this Amendment, claims 1, 7 and 8 have been amended and new claims 14-20 have been added. Claims 1-20 are pending in the application. In view of the above amendments and the following remarks, favorable reconsideration of this application is respectfully requested.

The Examiner rejected claims 1-13 under 35 U.S.C. 112, first and second paragraphs, as failing to comply with the written description requirement and as being indefinite, respectively. Applicant has amended the claims to bring them into compliance with 35 U.S.C. 112, first and second paragraphs.

With more specific reference to the rejection under 35 U.S.C. 112, first paragraph, Applicant has submitted with this Amendment two accepted reference documents available from public sources which indicate that animal manure such as pig slurry has a known composition such that the identification of a composition as "pig slurry" inherently carries with it an understanding to persons of ordinary skill in the art of the meaning of the phrase "significant quantity of nitrogen" with reference thereto.

The first reference is a web page from Manitoba Agriculture and Food concerning a study performed during the period between 1996-1998, according to which swine manure contains an average of 1.7 kg/m^3 of ammonia, or approximately 1800 ppm. Similarly, the second reference, Manure Management (C.H. Burton, ed., 1997), pp. 26-27 and 120-121, shows in Table 4.1 that pig manure contains about 1.8 kg/m^3, or approximately 1800 ppm, of "available" nitrogen, i.e., nitrogen as ammonia or "inorganic nitrogen" as explained on page 26. As summarized in Table 4.1, animal manure contains typically between 0.9 kg/m^3, i.e., roughly 900 ppm, and 10 kg/m^3, depending upon the animal at issue.

Based on the foregoing representative documents, a person of ordinary skill in the art would know, when reading the present application and the references contained therein to pig manure, that pig slurry is heavily loaded with nitrogen on an order of magnitude of at least 500 ppm. Accordingly, favorable reconsideration and withdrawal of the rejection under 35 U.S.C. 112, first paragraph, is requested.

The Examiner rejected claims 1, 2, 4, 5, 7 and 8 under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 4,689,156 to Zibrida, and rejected claims 3, 6, 9 and 10 under 35

U.S.C. 103(a) as being unpatentable over Zibrida. The Examiner also rejected claims 11-13 as being unpatentable over Zibrida in view of U.S. Patent No. 5,653,149 to Klingspor et al. ("Klingspor").

The present invention is directed to a method and device for treating a liquid effluent of animal manure such as pig slurry which is loaded with significant quantities of nitrogen as ammonia and phosphorus, on the order of 2-4 kg/ton. The method comprises the steps of adding a basic reagent to a liquid effluent of pig slurry having at least 500 ppm to obtain a pH in the range from 8.5 to 13, diffusing the basified liquid effluent derived therefrom in a stream of air, and removing up to 80% of the ammoniacal nitrogen from the heavily loaded slurry. This is not disclosed by nor possible with Zibrida.

The scope of Zibrida is limited to the reduction of the ammonia content of wastewater from "in excess of about 15 ppm" (see Figure 1, step 10, and column 2, line 65) to "less than about 10 ppm" (see Figure 1, step 12, and column 3, lines 15-16). So the method of Zibrida is suitable for achieving a very limited removal rate from a starting material having a low initial concentration of ammonia.

The present invention, by contrast, is able to reduce the ammonia content of liquid effluents of animal manure which have a high concentration of nitrogen as ammonia, i.e., more than 500 ppm, performing a high removal rate of up to 80% of the ammonia (see the specification at page 9, line 8). Such a high removal volume and percentage requires a highly efficient device and is necessary for intensive farming of animals, where cultivation area is quite restricted, in order to be able to disperse more slurry without exceeding maximum quantities of nitrogen legally allowed.

Because Zibrida does not require high performance ammonia removal, Zibrida does not teach how to perform such a removal during the gas stripping of ammonia. Ammonia is gaseous, after the alkaline agent addition step, and this gas, NH_3, is well known to have a high affinity with liquid water, making it difficult to strip out of the water. Moreover, NH_3 is heavier than air and thus has a tendency to "fall" back into the water. These are some of the reasons why a method like "pond stripping", as described in Zibrida (see Figure 2 and column 4), may only lead to low NH_3 removal rates, even when "carried out in two or more stages" (column 4, line 55), or four stages in the case of Figure 3. The other method cited by Zibrida, namely "air

stripping (towers), also requires "two or more steps" (see column 4, line 29). In that two to four steps are required to achieve even the very low removal rate obtained by Zibrida, it is difficult to estimate how many steps would be required to accomplish the 80% removal of ammonia from a composition having hundreds or thousands of parts per million. Clearly, Zibrida is not comparable to the highly efficient and highly performing device according to the present invention.

The present invention is also highly adaptable to varying ammonia removal targets through adjustment of the operating conditions such as the air flow and the slurry flow rate. This is important because the average dry matter of pig slurries is 6% (60 kg/m^3), see Figure 4.1 in <u>Manure Management</u>, but may vary from about 5-10%. If the dry matter changes, the quantity of ammonia to be removed will change accordingly. Furthermore, available nitrogen may vary over time, namely increasing if the pig slurry is a few days old as compared with its initial value.

Finally, Klingspor is directed to a process for removing a gaseous acidic pollutant (SO_2) *from a gas* stream *by a liquid* slurry of calcium carbonate. This cannot be considered as anticipating the device according to the present invention which

removes a gaseous basic component (NH_3) *from a waste liquid* slurry *by an air stream*. Moreover, the device of Klingspor is only suitable for calcium carbonate that has been finely divided "preferably by grinding... to achieve a weight median diameter of about 10µ or less, with 99% below 44µ" (see column 6, lines 42-44). Such a design of the tubes and spray nozzles would rapidly be blocked by the solid particles of various size found within animal manures such as pig slurries.

For at least the foregoing reasons, claims 1 and 8 are patentable over the prior art. Claims 2-7 and 9-20 are also in condition for allowance as claims properly dependent on an allowable base claim and for the subject matter contained therein. Specifically, the removal of 40%, 60% and 80% of ammoniacal nitrogen from an input having at least 500 ppm, as set forth in claims 14-16, respectively, and from an input having about 1800 ppm, as set forth in claims 18-20 dependent on claim 17, respectively, is neither shown nor suggested by the prior art and is patentable thereover. Favorable consideration is requested.

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With this amendment and the foregoing remarks, it is respectfully submitted that the present application is in condition for allowance. Should the Examiner have any questions or comments, the Examiner is cordially invited to telephone the undersigned attorney so that the present application can receive an early Notice of Allowance.

Respectfully submitted,

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Typical Swine Manure Nutrient Content[1]

Table 4: Typical Swine Manure Nutrient Content[1]

Parameter	Total Nitrogen	Ammonia	Organic Nitrogen	Phosphorus (P2O5)	Potassium (K2O)	Dry Matter
	kg/m^3				2	%
Average content	2.54	1.71	0.75	1.82	1.44	2.8
Minimum	0.20	0.08	0.03	0.05	0.04	0.1
Maximum	6.90	5.15	4.25	11.78	4.44	12.5

[1] 1996-1998 data courtesy Norwest Labs, 545 University Cr. Winnipeg, MB R3T 5S6; See Appendix C for imperial units.
[2] 1kg/m3 = 1 kg/ 1000 L

(Table 4 should only be a last resort (refer to the Manitoba Agriculture fact sheet on "Manure as a Resource").

This book represents the product of a Concerted Action funded by the European Commission. Fourteen organizations involved in varying aspects of livestock manure treatment were represented in the series of workshops that made up this three-year collaboration. As a result, an objective review of the whole subject area is put together here. This volume explains the practical use of treatment techniques in the management of manures for the maximum benefit of the farm operation with the minimum harm to the environment.

MANURE MANAGEMENT Treatment strategies for sustainable agriculture

MANURE MANAGEMENT

Treatment strategies for sustainable agriculture

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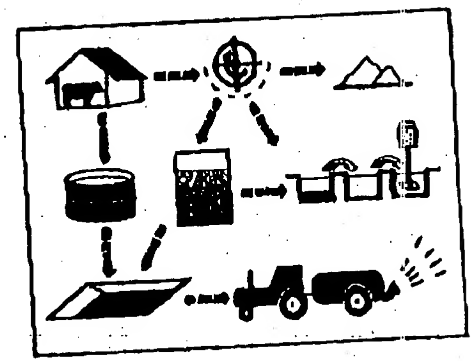

edited by C H Burton

MANURE MANAGEMENT

Treatment Strategies
for Sustainable Agriculture

Edited by
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Contents

Carbon dioxide (CO_2) arises mainly from air expired from the animals and to a lesser extent from the manure stored in the house. Hydrogen sulphide arises from the anaerobic bacterial decomposition of sulphur-containing amino-acids in the manure. Methane is formed by the anaerobic decomposition of fatty acids in the manure. Large amounts are also given off by ruminants. Ammonia is produced mostly by the decomposition of urea by naturally occurring urease.

Ammonia

Livestock manure is the most important source of ammonia emission in northern and central Europe (Buijsman *et al.*, 1987). Ammonia is lost by volatilization from the buildings, manure stores, during the land spreading process and following land spreading. Ammonia emission is an environmental issue because high concentrations (e.g. in the vicinity of the sources) can damage vegetation. Increased aerial deposition of ammonia (NH_3) and ammonium (NH_4^+) contributes to water and soil acidification and may be part of the complex system causing acid rain. Ammonia emissions are one of the principal sources for increased nitrogen (N) supply to natural areas which can change sensitive flora and contribute to eutrophication of aquatic ecosystems.

Relative ammonia emission factors for different livestock types are compared in Table 2.4. The greatest differences in reported values occur in the case of pigs and poultry which may reflect the wider variation in the housing systems used. The emission factor is also governed by the

Table 2.4 Ammonia emission factors* reported for different livestock types by different workers (Hartung and Phillips, 1994)

	Janssen	Buijsman	Möller	Asman
Cattle	25	18	26	25
Pig	21	17	39	30
Poultry	13	13	67	80
Sheep	34	31	36	19
Horse	11	9	18	12

*kg per 500 kg live weight

Table 2.5 Influence of the animal housing type on ammonia emission factor* (Hartung and Phillips, 1994)

	System	Factor	
Pig	Danish system	12	van der Eerden *et al.*
	Fully slatted floor	12	van der Eerden *et al.*
	Partly slatted floor	22	van der Eerden *et al.*
	Liquid manure	7	Kowalewsky
	Bedding	2	Kowalewsky
Laying hens	Liquid manure	39	Kowalewsky
	Solid floor with bedding	17	Kowalewsky

*kg per 500 kg live weight

type of flooring used as shown in Table 2.5. Particularly noticeable are the large differences between partly and fully slatted floors in the case of pigs and the effect of the frequency of manure removal in the case of laying hens. The influence of bedding material on ammonia emissions from pig manure were shown to vary in a range of 1 to 10 (Andersson, 1996). Because of the confusing multiplicity of data, Iserman (1990) proposes some average values for all animal species and types of slurry removal as follows:

- Housing area : 9.7 kg NH_3/LU.year
- Open dung-storage outside the house: 12 kg NH_3/LU.year
- Pasture: 7.5 kg NH_3/LU.year
- Land spread manure: 22 kg NH_3/LU.year

where LU is a livestock unit equal to 500 kg of live weight. The percentage contributions of ammonia emission from houses, stores, grazing and land application are shown in Table 2.6. In both cases slurry-spreading is a major source; relatively little is attributed to grazing.

The results of studies on deep-litter systems for fattening pigs were shown to reduce ammonia emissions compared with housing on fully slatted floors, but emissions of air-polluting nitrogen gases tend to be higher due to the formation of nitrous oxide (Groenestein and Faassen, 1996).

Manures are collected from livestock housing, non-bedded yards both open and covered, and areas used for feed preparation, milking and silage making. Gravity collection of liquids and scraping systems for solids are usually possible. Every effort should be made to minimize dilution from water leakage and washing water and especially by rain-water; it may be cheaper in some of the wetter regions to cover open yards than to provide additional storage for dilute manure.

The transport of solid and liquid manures covers a wide range of problems and solutions. There are two movement types: there is the local handling around the farm, *e.g.* to and from the main store. In the case of liquids this typically involves gravity drainage via pipework to a central pit. Solid material in a well designed system may be scraped directly to store but this is not always practical and machinery may also be needed. Removing the various manures and effluents from the farm to the utilization areas may involve distances of several thousand metres. Typically, this implies tractor-drawn tankers and muck spread-ing equipment. For the pumpable liquids, there is also the option of pipework systems which imply investment but which can greatly improve the spreading operation.

Guidelines for safe and efficient manure utilization, prepared for the Commission of the European Communities (1989) under Cost Project 681, suggest that manures may be stored for agronomic, environmental or logistic reasons. Generally, there is a need to collect or contain manures for at least a short period prior to application to land. Longer-term storage is often desirable for the following practical reasons:

- To avoid the need for frequent spreading of manures onto land.
- To provide flexibility in the timing of the manure spreading campaign.
- To enable the use of contractors with specialist equipment at certain times of the year.
- To allow a continuous manure treatment option.

These in turn enable key environmental criteria to be met:

- To avoid over application to the land with the consequential risk of water pollution caused by effluent run-off.
- To avoid winter applications with the related risk of nitrate leach-ing into the groundwater.

- To avoid damage and contamination of the crop caused by untimely spreading.
- To optimize the plant uptake of nutrients in the manure.
- To avoid damage to soils by use of heavy application machinery when soils are vulnerable (*e.g.* during periods of high rainfall).

Livestock manures are recognized as a valuable source of the major crop nutrients nitrogen, phosphate, potash, sulphur and magnesium, and farmers have traditionally recycled them to maintain soil fertility and support plant growth. Table 4.1 not only highlights the presence of such nutrients in the various manures but also that there is a financial value to them which can be realized. Chambers (1993) concludes that although a number of problems still restrict the efficiency of nutrient utilization from manures, there is considerable scope, using present knowledge and commercially available machinery, for many farmers to make better use of the nutrient content of manures. The following represent the key areas:

Table 4.1 Typical nutrient content and value of poultry, cattle and pig manures

Manure type	Dry matter (kg/m^3)	Available nitrogen[1] (kg/m^3)	Total phosphate (kg/m^3)	Total potash (kg/m^3)	Potential value[2] (ecu/m^3)
Broiler	600	10.0	25.0	18.0	17.8
Layer	300	5.0	13.0	9.0	9.1
Cattle	60	0.9	1.2	3.5	1.7
Pig	60	1.8	3.0	3.0	2.7

1 Assuming spring application
2 Where: N @ 0.42 ecu/kg; P_2O_5 @ 0.36 ecu/kg; K_2O @ 0.25 ecu/kg

- Representative manure samples should be analysed to determine the concentration of the key nutrients. Quick on-farm methods can be used, *e.g.* a slurry nitrogen meter.
- Better timing of applications in relation to crop demand – spring applications have generally been shown to be more efficient than those in the autumn (largely through decreasing nitrate leaching losses).